DESIGN A FLOOD CONTROL U CONCRETE DRAINAGE SYSTEM WITH FILTRATION DIRECTED TO THE PUYAT RIVER AT BRGY. KAYPIAN'S PHASE 3B, SJDM, BULACAN

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Bachelor of Science in Civil Engineering

Major in Construction Engineering

and Management

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RECOMMENDATION

This is to certify that this research entitled "DESIGN A FLOOD CONTROL U CONCRETE DRAINAGE SYSTEM WITH FILTRATION DIRECTED TO THE PUYAT RIVER AT BRGY. KAYPIAN'S PHASE 3B, SJDM, BULACAN," prepared and submitted by Edmon T. Castro., Shalom C. Guevarra, John Paul C. Ignacio and Areim S. Rosquites have been examined and PASSED the PRE-ORAL DEFENSE.

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This is to certify that this research paper was originally made by the researchers and does not contain any material previously published or written by another person nor material to a substantial extent of being accepted for an award or any degree of diploma in La Concepcion College and other educational institutions except where due acknowledgement is made in the research paper.

We also declare that the intellectual content of this research is a product of our own effort, conceptualization, and brainstorming in aiming to improve certain problem of our society. Any contributions made to the research of others is explicitly acknowledged in this paper.

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TABLE OF CONTENT

page

Title page i

Recommendation…….ii

Certificate of Originality…….iii

Table of Content……..iv

CHAPTER 1

The Problem and Its Background

Introduction 1

Background of the Study..... 2

Theoretical Framework.....4

Conceptual Framework.....5

Statement of the Problem 7

Objectives of the Study..... 8

Hypothesis.....9

Significance of the Study..... 9

Scope and Limitation.....10

Definition of Terms..... 11

CHAPTER 2

Review of Related Literature

Foreign Literature 12

Local Literature.....15

Foreign Study 19

Local Study 21

Synthesis of Review of Related Literature and Study.....26

CHAPTER 3

Research Methodology

Research Design 28

Population Sample 29

Research Instrument 29

Data Collection 31

Statistical Treatment Data.....31

Structural Analysis Method……33

CHAPTER 1

The Problem and its Background

This Chapter provides an overview of the study that includes the Introduction, Background of the study, Theoretical framework, Statement of the problem, Hypothesis, Scope and limitation of the study. Significance of the study, and Definition of terms. This part discusses the problem and the information about the concept of researchers aim to provide a solution to.

Introduction

The Philippines has always been vulnerable to natural disasters, and several parts of the country are often left to endure the typhoon from pacific and recover from the effects of these calamities. An average of 20 tropical cyclones enter the Philippines Area of Responsibility (PAR) each year and with the climate change it may go up to 30 or more. These generally always produce heavy rains and flooding across large areas, and flooding can be considered one of the most destructive natural disasters that usually involves great property losses. The effects of floods rank among the most significant calamities globally.

According to Tuazon et al., floods are becoming more frequent and raise the risk of experiencing emotional distress, anxiety, and PTSD. Another issue brought about by flooding is its effects on the physical health of people. For instance, the emergence of infectious and vector-borne diseases is a growing problem caused by

the interplay of various factors, including climate change, rising sea levels, urbanization, and the geographical vulnerabilities of certain locations.

The existing drainage system can't manage the flood water that came from the storm water or typhoons, combined with the prevalent issue of improper solid waste disposal that was created by humans. During heavy rainfall some plastics, debris, and other solid waste are washed into the roads that may clog the drainage networks and exacerbate the flooding. This not only causes prolonged road inundation but also leads to the pollution of nearby rivers as debris fills the waterways, harming the local ecosystem and contributing to the unsanitary conditions.

The purpose of the study is to address the dual problem by designing a concrete drainage system with filtration components. Unlike other traditional drainage systems that only divert the water and can't be filtered, this design actively separates the solid waste from storm water and directs it to the river. The system will act as a treatment for rivers that will not affect the ecosystem and it will reduce waste. This ensures the drainage remains functional during peak flood events while improving the quality of water discharge into the river.

Background of the Study

The flooding is a natural issue at phase 3B particularly in typhoons or heavy rainfall, the intensive rain often results in stagnant water that may accumulate in the street and may cause flooding. Disrupts the daily activities of residents like walking,

jogging events and transportation, posing a significant challenge to the community at phase 3b. These floods are not caused by rivers, but are caused by storm water runoff. Due to the absence of adequate or properly designed drainage systems within the barangay. In response to these challenges, this study developed a drainage system that is capable of handling intense rainfall and mitigating floods.

The lack of drainage infrastructure is a prevalent issue of improper waste management in the community and absence of a systematic garbage collection system with the residents limited public awareness. That led to indiscriminate disposal of plastic and other non-biodegradable materials which this debris is washed in the streets directly contributing to the blockage of existing canals. The combination of inadequate waste management and insufficient drainage capacity creates a cycle of problems where flooding is not only frequent but is severe due to human factors. The impact of stormwater runoff in Phase 3B is further amplified due to ongoing urbanization where land development affects the surrounding area.

The barangay kaypian phase 3B was identified as the catchment basin for the proposed drainage system. This study will not only provide a practical solution but also aims to contribute to a green initiative drainage. Moreover, this study is to seek a contribution for environmental sustainability in urban areas by integrating a green engineering concept into the drainage design. Through initiative, the proposed system will not only address in immediate flooding concern but also to promote waste management and environmental protection

Theoretical Framework

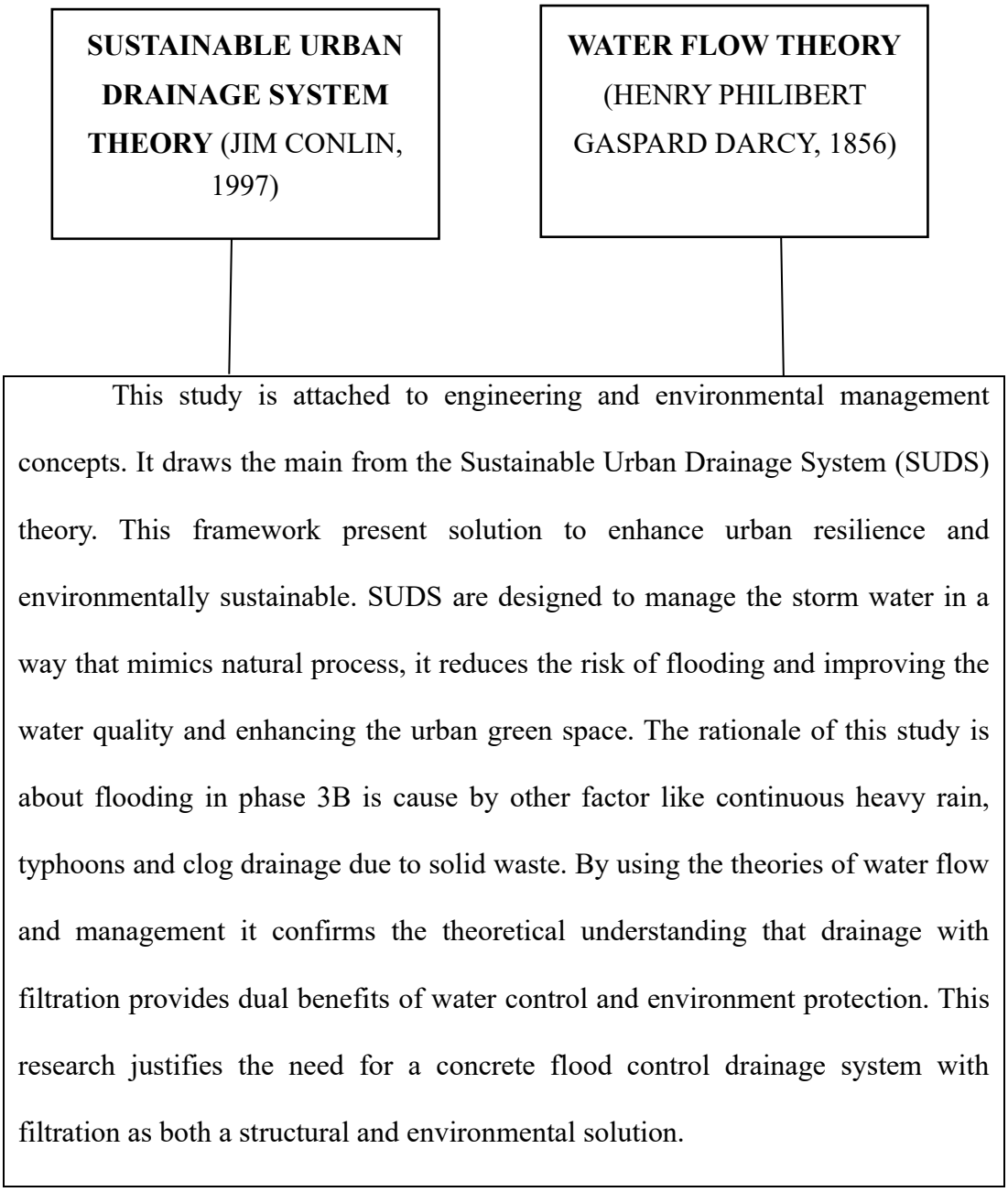
SUSTAINABLE URBAN DRAINAGE SYSTEM THEORY (JIM CONLIN, 1997)
WATER FLOW THEORY (HENRY PHILIBERT GASPARD DARCY, 1856)
This study is attached to engineering and environmental management concepts. It draws the main from the Sustainable Urban Drainage System (SUDS) theory. This framework present solution to enhance urban resilience and environmentally sustainable. SUDS are designed to manage the storm water in a way that mimics natural process, it reduces the risk of flooding and improving the water quality and enhancing the urban green space. The rationale of this study is about flooding in phase 3B is cause by other factor like continuous heavy rain, typhoons and clog drainage due to solid waste. By using the theories of water flow and management it confirms the theoretical understanding that drainage with filtration provides dual benefits of water control and environment protection. This research justifies the need for a concrete flood control drainage system with filtration as both a structural and environmental solution.

Figure 1.0: *The Theoretical Framework.*

Conceptual Framework

INPUT	PROCESS	OUTPUT
1. What is the demographic profile of the respondents in terms of: a.) Age b.) Gender c.) Type of respondents d.) Years of Stay in the Area 2. How does the flooding in the area be assessed in terms of: 2.1 Capacity of the Existing Drainage System 2.2 Poor Drainage Design 2.3 Clogging due to Waste Accumulation 2.4 Lack of Maintenance and Regular Cleaning 3. How does the physical properties of the U-concrete drainage system with filtration affect its ability to manage stormwater during heavy rainfall in terms of:	1. Data Gathering - Conduct survey among residents, students, and drivers - Collect rainfall, flood incidents, and PAGASA data - Obtain maps and existing drainage layout 2. Assessment and Evaluation - Evaluate current drainage capacity - Identify common causes of flooding - Analyze the effect of waste accumulation 3. Engineering Analysis & Design - Calculate flow capacity of the proposed U-drain - Determine appropriate slope and dimensions - Integrate filtration system for solid waste removal - Check structural behavior using AutoCAD/SketchUp	1. A Functional U Concrete Flood Control Drainage System with Filtration - Designed to handle heavy rainfall and stormwater - Prevent clogging through integrated filtration - Reduce flood level in Phase 3B 2. Cleaner Water Discharged into Puyat River - Lower suspended solids - Less debris and plastic waste - Improved water quality 3. Safer and More Resilient Community - Reduced disruptions to residents, student and drivers - Better road accessibility during rainfall - Environment friendly drainage rainfall

3.1 Fluid Capacity and Hydraulic Efficiency 3.2 Structural dimensions and slope 4. How does the integrated filtration system in the U-concrete drainage system performance affect the water quality released into the Puyat River in terms of: 4.1 The Reduction of total suspended solids (TSS) 4.2 The Reduced Debris and Plastic Waste 4.3 Improved Water Turbidity (pH)	4. Water Quality Evaluation - Assess ability of filtration to reduce TSS - Evaluate debris capture efficiency - Predict improvement in water clarity before reaching the river	4. Reference Data for Future Researchers - Provide technical design basis - Flooding assessment results - Supports sustainability and urban planning initiatives

Figure 2.0: *The Conceptual Framework illustrating the input, process, and output of the materials and data.*

Statement of the Problem

This study aims to design a flood control U concrete drainage system with Filtration to discharge a clean water into the river. This design is to provide an effective drainage and sustainable solution to minimize the flooding in the area and improve the water flow. The researchers intend to promote a safety, convenience, and resilience among all the residents of Phase 3B, especially those who are most affected by flooding during typhoon and heavy rains.

This study seeks to address the following research question:

1. What is the demographic profile of the respondents in terms of:

    a.) Age

    b.) Gender

    c.) Type of respondents

    d.) Years of Stay in the Area

2. How does the flooding in the area be assessed in terms of:

    2.1 Capacity of the Existing Drainage System

    2.2 Poor Drainage Design

    2.3 Clogging due to Waste Accumulation

    2.4 Lack of Maintenance and Regular Cleaning

3. How does the physical properties of the U-concrete drainage system with filtration affect its ability to manage stormwater during heavy rainfall in terms of:

3.1 Fluid Capacity and Hydraulic Efficiency

3.2 Structural dimensions and slope

4. How does the integrated filtration system in the U-concrete drainage system performance affect the water quality released into the Puyat River in terms of:

4.1 The Reduction of total suspended solids (TSS)

4.2 The Reduced Debris and Plastic Waste

4.3 Improved Water Turbidity (pH)

Objective of the Study

This study aims to design a U-shaped concrete drainage system with an integrated filtration to help mitigate flooding in Phase 3B, Brgy. Kaypian. It intends to improve stormwater flow and reduce overland runoff during heavy rainfall and typhoons.

General Objectives

To develop an effective flood control U-shaped concrete drainage system with an integrated filtration that can reduce flooding, manage stormwater and promote cleaner water into the Puyat River for the residents of Phase 3B, Brgy. Kaypian.

Specific Objectives

1. To determine the demographic profile of the respondents such as age, gender, type of respondent, and years of residence to help us interpret the results accurately.

2. To assess the major causes of flooding in Phase 3B based on respondent's observations and technical factors, including drainage capacity, design issues, waste accumulation, and maintenance practices.
3. To design a U-shaped concrete drainage system with integrated filtration that can effectively reduce flooding and improve water quality.
4. To evaluate the effectiveness of the U-shaped concrete drainage system with integrated filtration, in managing stormwater during heavy rainfall and improving water quality prior to its release into the Puyat River, by assessing its physical properties.

Hypothesis

Ha. The use of flood control U concrete drainage system with filtration has no significance effect on reducing flood damage in Brgy. Kaypian Phase 3B.

Ho. The use of flood control U concrete drainage system with filtration has significantly reduce flood damage in Brgy. Kaypian Phase 3B.

Significance of the Study

This study on flood control U concrete drainage is to address the growing problem of flooding in communities and environment. The climate change increases the heavy rain and many natural disaster's felt in this country. This research can serve as foundation for future studies aiming to improve adaptive measures and policy making in flood prone areas.

This study is beneficial to the following:

Resident of Phase 3B gain directly from the study since it makes the community safer and more resilient. The flood U concrete drainage system can reduce property damage from flooding

Riders and Commuters can avoid flooding that are causing problems to them. The effective drainage solution promotes safe and smooth transportation roads, by eliminating delays and maintain access.

Future Researchers can review this paper, for future purpose of viewing and may use to investigate flood control methods. The paper offers great insight, data for the flood that can be used for inspiration when designing drainage systems.

Scope and Limitation of the Study

This study is to focus on the design of a flood control U concrete drainage system with filtration for Phase 3B Brgy. Kaypian, SJDM Bulacan, the researcher aim is to create a concrete drainage system for Phase 3B that able to stand against the high amounts of trash such as organic matter, domestic waste and large household waste that are carried by storm water or the typhoon that can flow direct to the river and to be filtrated. The system will include the filtration feature to prevent blockages and improve the flow of water from the drainage to river. The participants of this study will be the resident of Phase 3b, as well the students and driver who are affected by flood. A survey will be conducted to gather data about their experience and observations on existing drainage system and by this to determine the improvement

for better flood control. The 30 participants preferably residents, students, and driver within Phase 3b will answer a set of questionnaires to provide information for development of this research. The study will only cover Phase 3b of Brgy. Kaypian and will not include other's phase connected to Ilog Puyat.

Definition of Terms

Climate Change - The change of weather especially due to increase in the temperature of earth's atmosphere that is caused in part by the increase of carbon dioxide. In this study, it is the recognized as key factor intensifying the severity of heavy rainfall events and typhoons.

Drainage System - A drainage system is an arrangement to move liquids away from they are not required for disposal in appropriate locations. For this research, it refers to existing and proposed infrastructure within Brgy. Kaypian Phase 3B.

Filtration - A process or device that removes solid particles or pollutants from water. In this study, it is the core function of the integrated component within the proposed U-Concrete Drainage System.

Flood Control - The prevention of the overflow of large amount of water beyond its normal limits. The structural methods and engineering works employed to prevent flooding. This study focuses on designing a concrete drainage system as flood control.

Flood Mitigation - The strategies taken to reduce flood risk and potential impact on communities and the environment. The use of land-use planning, early warning systems with the community preparedness reduce physical and socioeconomic damage of floods in the area.

Sustainable Urban Drainage Systems (SUDS) - The drainage system that are considered to environmentally beneficial, causing minimal or long-term detrimental damage. Unlike traditional system that focus only on rapid conveyance, The SUDS emphasizes infiltration, evaporation and slow conveyance. This study is grounded in SUDS principles by integrating filtration to improve water quality before discharge to the river.

CHAPTER 2

Review of Related Literature and Studies

This section contains the gathered related pieces of literature and studies, both foreign and local. Literature encompasses the insights provided by the author in books, newspaper, articles, and various written sources. While studies encompass the discoveries made by diverse researchers. The collected literature and studies are relevant to current research, contributing to the enhancement of its framework.

Foreign Literature

Dr. Palaka's (2021) design of Urban Storm Water Drainage, the rapid growth of village and towns affecting natural drainage channels. It affects the low-lying areas is a common phenomenon especially during rainy season and typhoon in many localities in Narsapur Town. With the increased of demand for a proper drainage system, the municipal Authorities decided to re- design the storm drainage system ate Narsaour Town with mapping the existing road network and drains. The Naparsur Town has 15 revenue wards. Considering the topography of the town, the entire town was divided into six zone. The author conducts case studies of the cities including the Narsapur town to reduce the properties and environment losses due to the storm water or typhoon. This writer outlines how to resolve the economic losses, redesign the drainage and tactile guides increase very significantly the accessibility of the facilities

for all residents of Naparsus (Dr. Palaka, 2021) Design of Urban Storm Water Drainage System Using GIS and SWMM Software.

According to Reza Mehdizadeh Anvigh, Jose Figueiredo Silva and Joaquim Macedo (August, 2024) heavy rainfall is a natural phenomenon reinforced by climate change and global warming, ca cause severe social, economic, and safety impact. Due to impact of climate change, heavy rainfall events have become more frequent and intense in recent year. The present study identified areas in Urmia City, Iran, that require stormwater management to develop a comprehensive understanding of the hydrological processes. Flooding during heavy rainfall is a natural phenomenon that occurs when the amount of precipitation surpasses the capacity of the soil absorb, the amount of precipitation events in the US has increased in recent decades (1%). The author's conduct a studies designing and implementing sustainable drainage system models that the regions are facing heavy rainfalls to effectively manage and minimize the adverse impacts of such events.

According to Alam, Rahma and Yunus (2023) the SWMM design based on study that address to chronic drainage congestion and frequent urban flooding at the economic zone of southern district of Dhaka at Shantinagar, Rajarbag, Motojheel, Paltan and T&T Colony. The author developed a detailed design of hydrologic hydraulic model using the EPA-SWMM for local rainfall and observed flooding, subdividing the study area into numerous sub catchment to represent the drainage pathways and build up some areas. The using of event simulations and design storm, they evaluated the existing conduit capacities. Dhaka contributes an applied example

of SWMM roles in urban flood for mitigation and complements methodological advantages in SWMM applications.

According to Wang (2024) they examined the innovative design strategies for urban underground drainage by analyzing the international case studies and practices. The study is highlighted the limitations of their conventional drainage network that are addressing the growing challenges of urbanization, climate change and intensified storm water. As their response, Wang emphasized the integration of green grey infrastructure, with combined of underground drainage network with sustainable surface level features as infiltration basin. Wang indicate the importance of maintenance, monitoring, and stake holder participation.

Xu et al investigate the effectiveness of smart rain barrels for urban pluvial flood mitigation (2025) this densely was build up for residential areas, using Saitama City near at Tokyo as a case study. This study was motivated by the increasing frequency of short duration, due to high rainfall intensity that are often happen in urban areas they used drainage system. Unlike the traditional they use a rain barrels, the smart version studied were equipped with controllers and sensors that may release a stored water before the storm landfall to maximize the availability of storage capacity during rainfall or storm surge.

Local Literature

Palcis (2024) explain that Philippines faces challenges like drainage overflow, increase flood and environment pollution. Traditional drainage systems are lacking in mitigating the problem. The author explores more solution to solving flooding by Integration of Sustainable Urban Drainage System (SUDS) for sustainable and resilient urban. The existing drainage shows many performance issues during heavy rainfall, leading to flooding and high maintenance cost. According to the author the SUDS benefits the Philippines for enhancing flood management and managing storm water, contribute to better water quality by filtering water. SUDS provide cost saving and easy maintenance than traditional ones. Palcis (2024) Integrating Sustainable Urban Drainage Systems (SUDS) for Enhanced Urban Resilience and Environmental Sustainability in the Philippines

Bañados and Quijano (2022) research work looks into the planning and managing water resource using of remote sensing and GIS, for developing countries like Philippines. This study show that a minor resource can be used to produce a rainwater retention suitability map and come up with ideal sites to divert surface runoff from flooding the stress and obstructing traffic during rain events. According to author the urban waterlogging is caused by impervious surface coverage and increasing rainfall intensity due to climate change and variability, which means stormwater cannot infiltrate the ground and excessive runoff cause urban flooding. In this research paper the area of City of Mandaue of Cebu a highly urbanized city, a geospatial approach has been utilized to identify suitable sites for rainwater retention areas using

remote sensing and Geographic Information System (GIS), the ideal sites for rainwater retention are produces in order to divert surface water. Ideally the chosen sites should have high infiltration capacity and be located in open spaces.

Bañados & Quijano (2022). Rainwater Retention Site Assesment for Urban Flood Risk Reduction and Flood Defence in Mandaue City, Philippines. ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences.

Tuazon (2025) at the Design of Drainage System for Flood Mitigation using Storm Water Management Model System", The study designs a drainage system for flood solution to solve the challenges of recurring flooding that have been persistent issue in Barangay Sta. Monica, Pampanga. The growing problem of flooding is cause by the many factors, including climate change, rising sea levels in the world, urbanization. In areas with high population densities, flooding is found to be a problem by lacking drainage infrastructure. The author explains that by enhancing the design and capacity of the urban drainage can improve the overall function of the drainage network and results in lower risk of flooding. In the Philippines, flood mitigation strategies are critical given that the country is susceptible to flooding. Different approach and method can apply to address this issue, for instance the use of real time flood forecasting models which include the River Analysis System (RAS) and Hydrologic Modeling System (HMS) is a way to safeguard people and infrastructure. Flood mapping and modeling can be improved even further with integration of Geographic Information Systems (GIS) with Light Detection and Ranging (LiDAR). This study not only sought to provide a practical solution for flood mitigation in Sta.

Monica but also aims to contribute in the achievement of the United Nation's Sustainable Development Goals (SDGs) specifically focusing on fostering sustainable cities and communities. Tuazon (2025). A proposed design of drainage system for flood mitigation in Barangay Sta. Monica, San Simon, Pampanga using storm water management model and Hydrologic modeling.

Calot (2022) on Sustainable Drainage System: Low impact Development Practice to Minimize the Storm Water Runoff explain that Low Impact Development (LID) is a green infrastructure that will ease water runoff impending problem due to climate change. Calot aims to determine LID control what is suitable on Barangay San Rafael, San Jose Del Monte, Bulacan by using Storm Water Management Model (SWMM). The study used three different LID practices and by this obtain the data to improve the ideal combination. The Bioretention Cell, Bioswale and Permeable Pavement have different function and the Bioretention Cells are use in parking lot, traffic and driveway runoff. Bioswale is the best combination of the three because it is green sustainable solutions that are linear vegetated ditch serving as natural and alternative storm drains. The Permeable Pavement is a type of pavement that allows rainwater and liquid to pass through to surface and ground below. Calot (2022) Sustainable Drainage System: Low Impact Development Practices to Minimize the Storm Water Runoff.

R. A Frias and M Maniquiz – Redillas (2021) on Modelling the applicability of Low Impact Development (LID) technologies in a university campus in the Philippines using Storm Water Management Model (SWMM). The study

evaluates the effect of Sustainable drainage solutions to solve stormwater runoff in a campus setting. The use of SWMM software makes the simulated result of using many LID technologies such as Bioretention Cells, Permeable Pavements. The findings in a simulated results revealed the integration of these systems minimized flooding risk and enhanced natural filtration. The study highlights the importance of applying LID technologies in many urban areas in Philippines, where rapid urbanization and limited drainage capacity can cause flooding. The research demonstrates the SWMM as reliable decision support tool in design and implementing sustainable drainage system for local conditions. R. A Frias and M Maniquiz – Redillas (2021) Low Impact Development (LID) technologies in a university campus in the Philippines using Storm Water Management Model
(SWMM).

Foreign Studies

According to Lin et al (2023) they investigated the used of rain barrels and rain gardens in Miyabara Cho, Saitama City, Japan. The study revealed that the using of rain barrels alone reduce the runoff slightly, rain gardens has more significant effect, and the combination of both will provide a highest reduction nearly of 30% during short storms. It shows that the combining of multiple low-impact development measures is more effective than using a single one. They examined the smart rain barrels near at Tokyo, they found out the forecast control barrels reduced the runoff by

2-10% more than in traditional ones, especially the larger capacity storage. It highlights the role of smart technologies in enhancing the urban flood mitigation.

In the study of Wang (2024) the modern approaches by designing the underground urban drainage system through review in international case studies for best practice in project. The study began by documenting the short coming of traditional underground drainage networks in coping the increasing urban floods, risk, intensity storm water and climate changes. To address these issues, Wang identified the several design innovations to improve the design. Wang underline the engineering strategies alone but not sufficient, the successful of this design are depend to the maintenance, monitoring flow condition and user to ensure the sustained performance.

The objective of Research Study of Daming Luo, Kanglei Du and Ditao Niu (2025), Is to deploy an intelligent diagnosis system to detect the blockages, structural defects and hydraulic anomalies early happen, prioritize the inspections and reduce the emergency repairs. They deploy a sensor suite to investigate the manholes or pipes using the ultrasonic or continuous water pressure, vibration sensors inside to access the point of detecting impacts and CCTV inspections using robots. The study concludes that using intelligent diagnosis it enhancing the decision making, its effectiveness depend on the robust communication, careful sensor selection, and the commitment to act on diagnostic outputs.

In the study if Dheka, Iqbal and Zaky Jasman in the M. Yamin (2024) road are experiencing the frequent roadside ponding and surface runoff during heavy rains. The existing open drains are undersized, prone to scour, and difficult to maintain and clean,

causing by localized flooding that interrupts traffic and damage the pavement edges. The public works department elected to replace or upgrade the sections of the road using precast U ditch channel to improve the capacity, durability and easy maintenance will minimizing the traffic disruption during the construction. The Objective is to provide a durable, hydraulic adequate roadside drainage channel that can stay longer 2 to 10 years without overtopping.

Jilong li and Xin Chen (2022) on Design and Mechanical Properties of U – Section Precast Concrete Box Culverts by improving the structural design and performance of U section precast concrete box culverts (UPCBCs) commonly used in urban drainage and underground water managements systems. The research highlights a key challenge in UPCBC design is stiffness of joints between precast. The author proposed seven simplified two-dimensional models base on simulations of joint constraints. The cantilever model under axial compression is the most suitable for design a single barrel UPCBC that are connected by unbonded prestressed bars. The study validated the design is reliable by demonstrating the proposed models have scientifically results by findings of design and durable U section precast culverts.

Local Studies

Contreras et al., (2023) presented in research paper that flooding is a problem that requires prompt attention as it endangers the health and safety of the general public, homes and business and interrupts transportation. This study is, “Enhancing

Flood Resilience: Evaluation of Current Drainage Design and Recommendation of the Provision of Cistern Tank with Pumping System" identifying a viable solution that will provide relief to the affected residents from disastrous flooding in the study area. The hydraulic performance of the existing storm drainage system design was assessed using Manning equation and Rational Method, and a suitable drainage system design is proposed. This study recommended suitable strategies to mitigate the effects of the area of the study, such as provision of cistern tank with pumping system. The Philippines is a disaster hotspot given its location in a region where climate and geographical storms are prevalent. According to PAGASA, more tropical cyclones (TC) than anywhere else in the world are making landfall in the Philippines Area of Responsibility (PAR). Approximately 8 to 9 of the 20 TCs that passes this area on average each year also cross Philippines. Nearly 70% of all typhoon develop during the peak of the typhoon season, which last from July through October. The country will unavoidably endure natural disaster such as tropical storm, and these will cause damage to property and infrastructure facilities. Flooding caused by the accumulation of rainwater in low-lying areas is widespread phenomenon observed across numerous regions and globally. The result of rainwater flood due to low elevation urban areas, where concrete and other surfaces prevent the water from soaking into the ground. The water flows on the surface, picking up waste and debris in the pathway it traverses to drainage. In the Philippines, installing cistern tanks with pumping equipment help reduce flooding in local communities. In metropolitan area especially in low-lying neighborhoods that are prone to flooding, underground cistern tanks can store

rainwater and greatly minimize flooding. In metropolitan area where typical stormwater management systems are difficult to deploy due to high population density and a lack of open space, the study claims that rainwater collecting is an efficient way to reduce floods. A pumping system for flood water disposal can be an excellent tool for managing to flood and protecting communities. Contreras, (2023). Enhancing Flood Resilience in San Guillermo Village, Pampanga, Philippines: Evaluation of Current Drainage Design and Recommendation of the Provision of Cistern Tank with Pumping System.

Almendras et al., (2023) presents research studies, “System Technology Management of Drainage System as Basis for Adoption”, the study was conducted at Cebu Technological University. As cities grow and face increasing climate change and urbanizing challenges, the durability and efficient drainage systems are needed. Innovating technology using in urban drainage systems can significantly improve management effectiveness. Getting accurate data of drainage systems through real-time monitoring can improve efficiency. The ease of operating it remotely and automation enable quick response, and use of rain harvesting is to promote resource conservation. Technologically citizen engagement raises awareness and encourages involvement. Successful use requires careful consideration of cost of the system and the compatibility of it with data privacy and cyber security. There is a growing recognition of the need for creative solutions for managing drainage systems. System technology management that integrates technological innovation into system design has the potential to address urban drainage system challenges. The author conducted a

study to innovate the drainage system at the Cebu Technological University Pinamungajan Campus to prevent floods within the campus. The drainage system is upgraded to catch ground rain using perforated pipes. The study includes many several materials of cement, sand, gravel, water, reinforced bars, and Polyvinyl Chloride (PVC). And by using this innovative perforated drainage system, the author aimed is to address the problems associated with the previous drainage system. Almendras (2023). System Technology Management of Drainage System as Basis for Adoption

See, L. S. (2020) on Open Data Approach to Mapping Urban Drainage Infrastructure in Developing Communities highlights how open data methodologies can be used to map urban drainage systems where infrastructure is always lacking. The study integrated integrate satellite imagery, elevation data and open-source GIS tools to identify map drainages. This approach was important in an area where detailed engineering survey are limited by introducing accurate information critical for flood mitigation and sustainable urban planning. In Philippines such approach is applicable because many Local government units (LGU) face challenges in updating drainage maps due to budget and technical constraint. Urban cities like Metro Manila regularly encounter flooding due to poor drainage systems and open data mapping can serve as complementary tools to survey allow LGU to collect data easily. The collection of data can identify flood prone area zone and prepare a drainage intervention. With this the Philippines can avoid wasted of many resources to identify drainage problems. See, L. S. (2020) on Open Data Approach to Mapping Urban

Drainage Infrastructure in Developing Communities

Boongaling (2024) review a Assessment of Low Impact Development (LID) Strategies under Different Land Use in and Urban Sub Catchment in the Philippines that focuse on how a land use affect the effectiveness of mitigating stormwater. This study learns the persistent problem of flooding in cities in Philippines that are driven by rapid urbanization and increased problems like flooding with climate change. The researcher uses PCSWMM modelling by stimulating various LID methods such as Bioretention Cells, Permeable pavements, and Bioswale. The study revealed the rainfall intensity affects LID performance, as rainfall intensity increase time goes by the effectiveness of LID technologies decline. The Philippines is Susceptible to extreme weather storm that may cause an existing drainage system to be vulnerable to damage from natural disasters. Boongaling concluded the LID implementation in the Philippines are integrated in existing drainage systems and their finding may provide benchmarks or guidance for local governments. Boongaling (2024) review a Assesment of Low Impact Development (LID) Strategies under Different Land Use in and Urban Sub Catchment in the Philippines

Tungol (2025) on study of Design Proposal of a Drainage System in Sto. Domingo, Minalin, Pampanga using Storm Water Management Model (SWMM) as Analytical Tool for Flood Mitigation. The researcher finds outdated drainage systems in the area where they survey to be prone to many problems and cause flooding not mitigating. The lack of attention and maintenance can expand the problem into a big one for the local government if not address in time. The study shows the need of an improved and resilient drainage system that aligned with sustainable goals. The

method combined Hydrologic and Hydraulic analysis by using the Curve Number (CN) method and SWMM simulations. The CN method was use to estimate runoff potential and peak discharge and SWMM is used to model nodes, junctions and outfalls of drainage system. The result shows the proposed drainage design successfully manage runoff ongoing severe storms simulation. The study demonstrated the SWMM as reliable decision support tool for local government in the Philippines.

Synthesis Literature

The synthesis of these studies shows that flooding and poor drainage system are frequent due to climate change and infrastructure supporting the mitigation of flooding. Dr. Palaka (2021) and Anvigh, Silva & Macedo (2024) explain that heavy rainfall has become common and intense. They recommend using GIS mapping and applying (SUDS) to reduce property loss and environment damage. Palcis (2024) explain that traditional drainage system is prone to failure in heavy rain. Bañados & Quijano (2022) used of GIS and remote sensing in Cebu to locate rainwater retention. Tuazon (2025) design a Drainage System for Pampanga that is using storm water management models and GIS-LiDAR to support sustainable. Calot (2022) determine which Low Impact Development (LID) technologies are best suited for the said study area. R. A Frias and M Maniquiz – Redillas (2021) on Modelling the applicability of Low Impact Development (LID) technologies the integration of three modes of Bioretention Cells, Bioswale, and Permeable Pavements. The local studies show solution to problem by Contreras (2023) that cistern tanks with pumping system to

solve floods in Pampanga. Almendras (2023) says that a perforated PVC drainage System in Cebu for efficient and rain harvesting. Boongaling (2024) and Tungol (2025) promote Low Impact Development (LID) technologies that are Bioretention Cells, Bioswales, and Permeable Pavements with SWMM to improve drainage performance. Foreign Studies Wang (2024) emphasize the updated drainage systems with green infrastructure. Xu (2025) and Lin (2023) have study Smart rainwater management technology showing multiple LID measure that reduce runoff. Mehdizadeh Anvigh (2024) Alam, Rahma & Yunus (2023) highlights the use of Hydrologic and hydraulic modelling (SWMM) to identify flood areas and upgrade drainage system. The Study of Daming Luo, Kanglei Du and Ditao Niu (2025) Is to deploy an intelligent diagnosis system to detect the blockages, structural defects and hydraulic anomalies early happen. The author Jilong li and Xin Chen (2022) on Design and Mechanical Properties of U – Section Precast Concrete Box Culverts by improving the structural design and performance of U section precast concrete box culverts (UPCBCs) commonly used in urban drainage and underground water managements systems. The study of M. Yamin case (Dheka, Iqbal &Jasman) show that precast U ditch drainage has practical advantage of enhance capacity, durability and ease of maintenance for mitigation on road flooding. Foreign and Local studies agree that traditional drainage system is no longer feasible. Modern approach uses sustainable drainage system, GIS mapping and many Innovative technologies needed to manage flood. Stormwater Modelling and U Shape drainage are critical for upgrading urban flood management, reduce property damage and enhance resilience to climate change.

CHAPTER 3

Research Methodology

This chapter outlines the research methodology employed in the design of a flood control u concrete drainage system with filtration direct to the river for Brgy. Kaypian's Phase 3B, by designing a sustainable and easy maintenance drainage system that might help the residents of phase 3b especially the commuters, students and also the riders. The research methodology consists of the research design, research instruments, the design and the equipment used, and the data gathering techniques implemented throughout the study.

Research Design

For this study the researcher used a Descriptive Quantitative Research Design, which is suited for assessing existing drainage conditions, identifying causes of flooding, and the experience of residents, students, and drivers in the area. Through structured survey questionnaires, the researchers gathered measurable data that reflect residents' observation, concern and needs. The descriptive approach enabled the researchers to interpret these data and use them as foundation for designing a more effective U-shaped concrete drainage system with filtration.

Population and Sample

The population of the study consist of individuals who directly experience the effects of flooding during heavy rainfall and typhoons in Brgy. Kaypian Phase 3B. This includes local residents, students, and drivers who operate within the area. These groups were carefully selected because they have first-hand knowledge about drainage issues, water flow behavior, and flooding patterns.

Respondents	Number of Respondents
Residents	10
Students	10
Drivers	10
Total	30

Table 1.0: *Population Sample*

Research Instruments

To obtain accurate data for the study, the researcher utilized several research instruments and technical tools. These instruments ensured quantitative measurements were gathered, analyzed, and represented in the design of proposed U-shaped concrete drainage with filtration.

a. Survey Questionnaire

The researchers used a purposive sampling technique and prepared structured survey questionnaire to collect data from residents, students, and drivers in

Brgy. Kaypian Phase 3B. The questionnaire was designed to gather measurable responses that reflect community experience and perceptions regarding flooding and drainage issues.

b. Maps and Scaled Models

The researchers used Google Maps and Wikimapia to obtain the exact coordinates, boundaries, and terrain characteristics of Phase 3B. The researcher uses these maps to measure distance, visualize the flow direction of stormwater, and create scaled representation of the site area. These scaled models guided the accurate placement and sizing of the proposed U-shaped drainage system with filtration.

c. AutoCAD

The researcher used AutoCAD, a professional computer-aided design (CAD) software to develop detailed 2D plans and 3D representations of the proposed drainage system. It helped the researcher create accurate technical drawings, analyze structural dimensions, shape the geometry of the drainage layout, and ensure compliance with NSCP standards.

d. Rubric /Criteria

A rubric was used to assess the structural reliability, hydraulic performance, filtration effectives, and sustainability of the proposed design. These criteria allowed the researchers to evaluate whether the proposed drainage meets safety requirements, performs efficiently during heavy rainfall and typhoons, and reduce waste entering Puyat River.

Data Collection

The data collection for this study will employ a quantitative research method approach by utilizing quantitative data gathering techniques to address research questions. The primary instrument is a structured survey questionnaire to be conducted by researchers on residents, students, and drivers in Brgy. Kaypian Phase 3b is present in the area that is affected by flooding.

Applying the purposive sampling technique on 30 participants living, studying, and working around Brgy. Kaypian Phase 3b will be approached for the study. The survey will be self-administered face to face at carefully selected areas in the barangay with emphasis on privacy and accurate response. It also incorporates closed-ended questions to facilitate quantitative data collection that will help gain insights on the effectiveness and sustainability of the proposed drainage system.

Statistical Treatment of Data

Descriptive Statistics

Descriptive statistics were used to summarize and interpret the data gathered from the respondents. The following tools were employed:

Frequency and Percentage Distribution

This was used to describe the demographic profile of the respondents in age, type of respondents and years of stay in Brgy. Kaypian Phase 3B.

$$P = \frac{f}{N} \times 100$$

where:

P= percentage

f= frequency of responses

N= total number of respondents

Weighted Mean

This was used to determine the respondents' level of agreement on the indicators related to drainage condition history, flooding frequency and duration, impact on the community, community awareness and perceived need for drainage with filtration.

Formula:

$$\bar{X} = \frac{\sum(f \times x)}{N}$$

where:

f= frequency of each rating

x= scale value (1–5)

N= total number of responses

The verbal interpretation of the weighted mean was based on the following scale:

Scale	Range of Values	Verbal Interpretation
5	4.5 - 5.0	Strongly Agree
4	3.5 - 4.49	Agree
3	2.5 - 3.49	Neutral
2	1.5 - 2.49	Disagree
1	1.00 - 1.49	Strongly Disagree

Table 2.0: *Statistical Method*

Structural Analysis Method

The researchers used structural analysis software such as AUTOCAD and SKETCH UP to ensure the structural integrity and the overall reliability of the proposed design. A 3D model was created based on the dimensions and materials specifications of the design to simulate the different kinds of loading conditions that may affect the structure itself, including the rainfall load and dead loads. The analysis will provide critical data on its bending moments, shear forces, reactions on its supports and deflections. This data will serve as the basis for the evaluation of the safety and the performance of the drainage under real-world conditions.

Rubric/ Criteria

To ensure the proposed U-shaped concrete drainage system with integrated filtration meets engineering, environmental, and functional standards, a comprehensive rubric was formulated. This rubric evaluates the design based on four major criteria: Structural reliability, Hydraulic performance, Filtration effectiveness, and Sustainability and Maintainability. Each criterion is rated using five-point scale, allowing objective assessment of whether the drainage system is safe, efficient, and capable of supporting long-term flood mitigation in Phase 3B.

Criteria	**5** Excellent	**4** Very Good	**3** Satisfactory	**2** Need Improvement	**1** Poor
Structural Reliability	Fully meets structural standards; appropriate reinforcement and concrete grade; long-term durability ensured.	Structurally sound with minor areas for enhancement; nearly compliant with all structural requirements.	Stable but may require further checking for reinforcement, load capacity, or soil interaction.	Partially compliant; noticeable structural gaps may affect strength and durability.	Fails to meet structural criteria; unsafe for long-term use.
Hydraulic Performance	Ensures fast, unobstructed stormwater flow; prevents flooding even during peak rainfall.	Effective drainage under most conditions; minimal risk of overflow.	Performs adequately under normal rainfall; slight delays during heavier rainfall.	Slow water movement; prone to partial clogging or overflow during storms.	Ineffective drainage; frequent flooding even under ordinary rainfall.
Filtration Effectiveness	Efficiently removes solids and	Filters most waste materials	Basic filtration is achieved;	Low filtration performanc	No effective filtration; waste and

	debris; significantly improves water quality before discharge.	with minimal maintenance requirements.	some debris still passes through.	e; filter clogs easily or fails to trap major waste.	pollutants enter the river freely.
Sustainability and Maintainability	Long-lasting, low-maintenance, environmentally friendly materials used; excellent long-term performance.	Sustainable design with occasional maintenance needs.	Materials and system function are acceptable; moderate maintenance required.	Low sustainability; frequent repairs needed; short lifespan.	Not sustainable; difficult or expensive to maintain; negative environmental impact.

Table 3.0: *Rubric/Criteria*

Total Score Range	Performance Category	Interpretation
17–20	Highly Effective	The design meets or exceeds all structural and performance standards; ideal for implementation.
13–16	Effective	The design is sound and reliable, requiring only minor improvements.
9–12	Moderately Effective	Acceptable but in need of enhancement to achieve optimal performance.
5–8	Needs Improvement	Multiple issues identified; modifications and redesign are necessary.
4 and below	Not Acceptable	The design is unsafe or ineffective and should not be implemented in its current form.

Table 4.0: *Scoring and Interpretation*

VALIDATION LETTER

Dear Validators,

We hope this letter find you well.

We are fourth-year Civil Engineering students from La Concepcion College and we are currently working on our research study titled "Design a Flood Control U Concrete Drainage System with Filtration Directed to the Puyat River at Brgy. Kaypian Phase 3B, SJDM, Bulacan."

We are seeking for your help in validating our study. Your comments and suggestions will help us improve the accuracy and quality of our research. Your feedback will also guide us in making sure that our study meets academic and professional standard.

We truly appreciate your time and support in guiding us as we complete our study. Thank you very much for your kind consideration.

Sincerely,

Researchers:

Edmon T. Castro

Guevarra C. Shalom

John Paul C. Ignacio

Areim S. Rosquites

Noted by:

ENGR. ELOISA P. CADAG, MACT
Research Adviser

Validated by:

11/14/24

Engr. Jore Gil D. Galeza, Ph.D., MEM, SO2
La Concepcion College - Division Head of Civil Engineering

CERTIFICATE OF VALIDATION

This is to certify that the research questionnaire of the study entitled "**Design a Flood Control U Concrete Drainage System with Filtration directed to the Puyat River at Brgy. Kaypian, SJDM, Bulacan.**" Prepared by Edmon T. Castro, Guevarra C. Shalom, John Paul C. Ignacio and Areim S. Rosquites from Bachelor of Science in Civil Engineering students of La Concepcion College has been validated by the undersigned experts to ensure that the items are clear, relevant and appropriate to the study's objectives.

After careful review, the panel of validator find the questionnaire valid and suitable for data gathering process.

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Research Adviser

Validated by:

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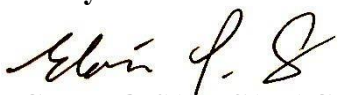

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Validated by:

Ar. Zgerlyn B Valientes, PH Z'aid

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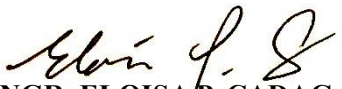

ENGR. ELOISA P. CADAG, MACT
Research Adviser

Validated by:

Allen Ry M Belisario, Teacher III, BSED, MaEd
Validator

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Research Adviser **Validated**

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Allen Ry M Belisario, Teacher III, BSED, MaEd
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Research Adviser

Validated by:

Loreen I. Cajanding, Teacher 1, BSED, MaEd
Validator

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Noted by:

ENGR. ELOISA P. CADAG, MACT
Research Adviser

Validated by:

Loreen I. Cajanding, Teacher 1, BSED, MaEd
Validator

Good day! We are Civil Engineering students from La Concepcion College, conducting a research writing and the purpose of this survey is to gather your honest opinions and experiences about flooding and your ideas for a better drainage system in our community. Your answers will help us improve the design of the proposed drainage system. All your answers will be kept private and used only for research purposes. Thank you for your time and cooperation!

Name (Optional): _____

Age: ☐ Below 18 ☐ 18–30 ☐ 31–45 ☐ 46–60 ☐ 61 and above

Gender: ☐ Male ☐ Female

Years of Stay in Phase 3B: ☐ Less than 1 year ☐ 1–5 years ☐ 6–10 years

☐ More than 10years

Type of Respondent: ☐ Resident ☐ Student ☐ Driver

Instructions: Please check (✓) the box that best shows what you think about each sentence.

LEGENDS:	**5** Strongly Agree	**4** Agree	**3** Neutral	**2** Disagree	**1** Strongly Disagree

I. This part is how well the drainage system can handle rainwater during heavy rainfall

	5	4	3	2	1
The drainage in our area can handle heavy rainfall.					
Water flows easily through the drainage when it rains.					
The drainage often overflows during storms.					
The size of the drainage is enough to hold rainwater in our area.					
The drainage needs to be widened to improve water flow.					

II. This part is how the drainage design or the structure cause flooding in your area

	5	4	3	2	1
The drainage needs to be redesigned for better water flow.					
The drainage structure makes it difficult for water to pass through.					
The slope of the road or drainage contributes to flooding.					
The drainage openings are too small to collect water quickly.					
The drainage system was not properly planned.					

III. This part if trash or waste cause the drainage to clog and flog the streets.

	5	4	3	2	1
The trash blocks the drainage during rain.					
The people in our area throw garbage into the canals.					
The waste makes it harder for water to pass through the drainage.					
The floods happen because the drainage is full of trash.					
The waste makes the drainage water smell bad.					

IV. This part if the drainage is regularly cleaned and maintained to prevent flooding

	5	4	3	2	1
The drainage in our area is cleaned often.					
The workers clean the canals regularly.					
The drainage looks dirty or full of mud most of the time.					
The regular cleaning would help stop flooding in our area.					
The poor maintenance causes water to flow slowly.					